DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
FY2006 STTR Proposal Submission

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified technical topics to which small businesses may respond in the fiscal year (FY) 2006 STTR solicitation. Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. Although they are unclassified, the subject matter may be considered to be a "critical technology." If you plan to employ NON-U.S. Citizens in the performance of a DARPA STTR contract, please inform the Contracting Officer who is negotiating your contract. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included followed by full topic descriptions. The topics originated from DARPA technical program managers and are directly linked to their core research and development programs.

ALL PROPOSAL SUBMISSIONS TO DARPA MUST BE SUBMITTED ELECTRONICALLY THRU WWW.DODSBIR.NET.

It is mandatory that the complete proposal submission -- DoD Proposal Cover Sheet, **ENTIRE** Technical Proposal with any appendices, Cost Proposal, and the Company Commercialization Report -- be submitted electronically through the DoD SBIR website at http://www.dodsbir.net/submission. Each of these documents is to be submitted separately through the website. Your complete proposal **must** be submitted via the submissions site on or before the **6:00am EST, 14 April 2006 deadline.** A checklist has been prepared to assist small business activities in responding to DARPA topics. If you have any questions or problems with electronic submission, contact the DoD SBIR Help Desk at 1-866-724-7457 (8am to 5pm EST).

Acceptable Format for On-Line Submission: All technical proposal files must be in Portable Document Format (PDF) for evaluation purposes. The Technical Proposal should include all graphics and attachments but should not include the Cover Sheet or Company Commercialization Report (as these items are completed separately). Cost Proposal information should be provided by completing the on-line Cost Proposal form. This itemized listing should be placed as the last page(s) of the Technical Proposal Upload. (Note: Only one file can be uploaded to the DoD Submission Site. Ensure that this single file includes your complete Technical Proposal and the additional cost proposal information.)

Technical Proposals should conform to the limitations on margins and number of pages specified in the front section of this DoD solicitation. However, your cost proposal will only count as one page and your Cover Sheet will only count as two, no matter how they print out after being converted. Most proposals will be printed out on black and white printers so make sure all graphics are distinguishable in black and white. It is strongly encouraged that you perform a virus check on each submission to avoid complications or delays in submitting your Technical Proposal. To verify that your proposal has been received, click on the "Check Upload" icon to view your proposal. Typically, your proposal will be uploaded within the hour. However, if your proposal does not appear after an hour, please contact the DoD Help Desk.

DARPA recommends that you complete your submission early, as computer traffic gets heavy near the solicitation closing and slows down the system. **Do not wait until the last minute.** DARPA will not be responsible for proposals being denied due to servers being "down" or inaccessible. Please assure that your e-mail address listed in your proposal is current and accurate. By the end of April, you will receive an e-mail acknowledging receipt of your proposal.

PLEASE DO NOT ENCRYPT OR PASSWORD PROTECT TECHNICAL PROPOSAL

HELPFUL HINTS:
1. Consider the file size of the technical proposal to allow sufficient time for uploading.
2. Perform a virus check.
3. Signature is no longer required at the time of submission.
4. Submit a new/updated Company Commercialization Report.
5. Please call the Toll Free SBIR Help Desk if you have submission problems: 866-724-7457
6. DARPA will not accept proposal submissions by electronic facsimile (fax) or email.

Additional DARPA requirements:

- DARPA Phase I awards will be Firm Fixed Price contracts.
- Phase I proposals **shall not exceed $99,000,** and may range from 8 to 12 months in duration. Phase I contracts cannot be extended.

- DARPA Phase II proposals must be invited by the respective Phase I DARPA Program Manager (with the exception of Fast Track Phase II proposals – see Section 4.5 of this solicitation). Phase 2 invitations will be based on the technical results reflected in the Phase I draft and/or final report as evaluated by the DARPA Program Manager utilizing the criteria in Section 4.3. DARPA Phase II proposals must be structured as follows: the first 10-12 months (base effort) should be approximately $375,000; the second 10-12 months of incremental funding should also be approximately $375,000. The entire Phase II effort should generally not exceed $750,000.

Prior to receiving a contract award, the small business **MUST** be registered in the Centralized Contractor Registration (CCR) Program. You may obtain registration information by calling 1-888-227-2423 or Internet: http://www.ccr.gov.

The responsibility for implementing DARPA's Small Business Technology Transfer (STTR) Program rests with the Contract Management Office. The DARPA SBIR/STTR Program Manager is Connie Jacobs, see address below. DARPA invites small businesses, in cooperation with a researcher from a university, an eligible contractor-operated federally funded research and development center (FFRDC), or a non-profit research institution, to submit proposals thru the DoD website www.dodsbir.net/submission.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
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STTR proposals submitted to DARPA will be processed by DARPA and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., "The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution" (refer to section 4.2 Evaluation Criteria - Phase I - page 7), twice the weight of the other two evaluation criteria. **TRANSITION OF THE PROPOSED EFFORT IS VERY, VERY IMPORTANT. THE SMALL BUSINESS SHOULD INCLUDE THEIR TRANSITION VISION IN THEIR COMMERCIALIZATION STRATEGY. THE SMALL BUSINESS MUST UNDERSTAND THE END USE OF THEIR EFFORT AND THE END USER, i.e., ARMY, NAVY, AF, SOCOM, ETC.**

As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may not fund any proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

- Cost proposals will be considered to be binding for 180 days from closing date of solicitation.

- **Successful offerors will be expected to begin work no later than 30 days after contract award.**

- For planning purposes, the contract award process is normally completed with 45 to 60 days from issuance of the selection notification letter to Phase I offerors.

SUBJECT/WORD INDEX TO THE DARPA FY2006.2 TOPICS

DARPA STTR 06 Topic Index

DARPA STTR 06 Topic Descriptions

ST061-001 TITLE: Scalable Information Assurance Strategies

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Identify, design, and evaluate new computer network protection strategies that scale with future network sizes as envisioned by the Global Information Grid.

DESCRIPTION: Network Centric Warfare and Operations, fundamental tenets of future military operations, will only be possible with the Global Information Grid (GIG) serving as the primary enabler of critical information exchange. Because the GIG will be the single most important contributor to combat power it will also be a primary target to our enemies. For this reason, the ability to protect information, defend systems and networks, and assure reliable and timely exchanges of information is essential. However, the envisioned size of the GIG and use of the IPv6 (Internet Protocol version 6) present new challenges to information assurance. For example, scaling address spaces by 27 orders of magnitude could impose an untenable work factor increase of 2^96 in some conventional edge-based protection strategies. At the same time threats are shrinking in size and signature, significantly reducing their equivalent 'signal-to-noise' ratio. As a result, many conventional commercial advisory and patch-based solutions will not be sustainable. Furthermore, encrypted core traffic will introduce new complexities to legacy defense-in-depth techniques. Because of this, new network-wide protection strategies for upstream security are sought, including new monitoring theories and sensing architectures that scale with the future GIG. Approaches that respond to specific emerging threats (botnets, rootkits, poly/meta-morphic autonomous code, etc) will be considered if it can be shown that they scale with future network sizes. New architectures that enable existing network sensors and logging appliances to be used at future scales may also be applicable.

PHASE I: Prepare a feasibility study to identify specific problems with conventional defense strategies that will emerge as a result of the size of the future GIG and possible solutions to address those issues.

PHASE II: Develop a prototype system in a realistic, large-scale environment and evaluate its effectiveness against future threats.

PHASE III DUAL USE APPLICATIONS: Solutions identified through this topic are applicable to the defense of commercial networks as well as military networks and have direct application to the civilian realm.

REFERENCES:
1. Rattray, G. J., "Strategic Warfare in Cyberspace", The MIT Press, Cambridge, Massachusetts, 2001.
2. "The Department of Defense Information Assurance Strategic Plan", V1.1 January 2004.
3. "Cyber Security: A Crisis of Prioritization", President's Information Technology Advisory Committee, February 2005.
4. Government Accountability Office, "The Global Information Grid and Challenges Facing Its Implementation", GAO-04-858, July 2004.

KEYWORDS: Information Assurance, Computer Network Defense, Global Information Grid.

ST061-002 TITLE: Automated Wide-Area Network Configuration from High-Level Specifications

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Development of a domain-specific language and implementation supporting automated Wide-Area Network (WAN) configuration from high-level specifications.

DESCRIPTION: It has been estimated that misconfiguration is the cause of 48% of wide-area network outages, that configuration accounts for 45% of the overall cost in maintaining such networks, and that 65% of attacks exploit misconfigured systems. Many of these network failures, costs, and vulnerabilities could be eliminated if configuration could be performed automatically from specifications written at a high level of abstraction. High-level specifications would be easier to write and understand, leading to fewer "fat-finger" errors and fewer conceptual errors. A high-level specification language would support theorem proving and other formal methods techniques leading to provably secure and correct network design. And to the extent that such a specification language were supported by automated compilers and interpreters, a large fraction of the time-to-deployment and personnel costs associated with wide-area network configuration could also be reduced. Therefore, this solicitation invites proposals for a breakthrough wide-area network configuration specification language and system.

There are many research challenges associated with developing an ideal network configuration domain-specific language and implementation. A powerful system specification language would abstract the configurations not only of network routers but also of "middleboxes" and network hosts. The specification language would support cross-layer configuration, not just configuration within a network layer. The specification language would be vendor-independent, but the implementation would support multiple vendors. The specification language would eliminate all configuration fault classes, and would completely automate current labor-intensive practices. The configuration language and system would support not only initial design and deployment but also the maintenance and incremental configuration transactions that are unavoidable over the course of a deployment. The formalisms behind the domain-specific specification language would be extensible in order to avoid language obsolescence as new requirements emerge. And access policy support would enhance security and prevent unauthorized configuration changes. Despite the fact that such an ideal is unlikely to be achievable in the near term, even a configuration system that falls short of the platonic ideal has the potential for breakthrough benefits in specific use cases.

Proposers are expected to describe the scope of their design, the theoretical foundations of their proposal, target transition customers and use cases, the objective criteria and metrics that their design is intended to achieve, and a specific basis of confidence that the criteria can be achieved. In particular, given that previous efforts to address this problem have not been entirely successful, it is essential for proposers to clearly highlight whichever novel insights distinguish the proposed effort from previous efforts. Proposers should strive for generality wherever possible, recognizing that although the STTR solicitation gives wide latitude in scoping useful short-term work, the proposed solution should make substantial progress in the direction of the platonic ideal.

PHASE I: Phase I must result in a feasibility study of core solution elements such as a preliminary specification language design (syntax and semantics), compiler architecture, and algorithms. Selective prototyping should provide confidence in the most challenging technical aspects of the proposed system. Phase I must also validate the applicability of the system for envisioned transition customers through means such as worked-through use cases and concepts of operations. The feasibility study should result in a refined understanding of system benefits to the target transition customers such as reductions in support cost and personnel, increased security, increased network availability, and enhanced network performance.

PHASE II: This stage must result in a proof-of-principle prototype implementation and demonstration and must engage potential customers to increase the likelihood of successful transition.

PHASE III DUAL USE APPLICATIONS: These applications should be both military and commercial in nature. Commercially, the system could support commercial Internet Service Provider (ISP) configuration, commercial enterprise configuration, or even home network configuration. Military applications include the configuration of IP-based (Internet Protocol-based) networks such as the Navy WANS within each Area of Responsibility (AOR), and/or perhaps even the more technologically heterogeneous C4 systems deployed to support Operation Iraqi Freedom or Operation Unified Assistance.

REFERENCES:
"Scalable Cyber-Security Challenges in Large-Scale Networks: Deployment Obstacles" especially Section 6.2 "Challenging Issues", available at http://cs-www.cs.yale.edu/homes/jf/LSN-report.pdf.

KEYWORDS: Wide-Area Network Configuration, Auto-Configuration, Provisioning, Specification Languages, Domain-Specific Languages, Formal Methods, Cybersecurity.

ST061-003 TITLE: Rosetta Phone

TECHNOLOGY AREAS: Information Systems, Electronics

OBJECTIVE: To extend real-time language translation efforts to operational settings of importance to DoD/IC (integrated circuit) customers.

DESCRIPTION: While progress continues on efforts related to speech translation, there are other types of real-time language translation that are of possible use to the warfighter, for example the translation of text in character sets which may be unfamiliar to an individual warfighter, such as Cyrillic, Kanji, Hebrew, Greek, Korean han'gul or Chinese characters. It is the goal of the Rosetta Phone effort to exploit cellular phones equipped with cameras to capture images of street signs, building placards or documents found in safe houses represented in unfamiliar character sets and languages. This difficult recognition and translation challenge may be addressed by using the combination of communications and local processing power found in latest-generation cellular phones. The idea would be to perform character recognition and language translation in concert to translate foreign character sets into spoken English. As appropriate, both image and translation could then be forwarded to other warfighters as necessary, via the communications capability of the device.

PHASE I: Conduct a thorough analysis of all the software/hardware issues related to design of a camera phone capable of capturing and translating foreign character text images in real time. Identify potential risk areas (such as image fidelity, processing power and whether communication to remote servers is required for present generation devices) as well as strong candidates for demo hardware and software.

PHASE II: Develop or modify a piece of hardware that would be of use to a warfighter, capable of real-time capture and translation of text from street or building signs.

PHASE III DUAL USE APPLICATIONS: In addition to being of immediate use to the DoD, the products developed in Phase II could find a niche among foreign travelers of all types.

REFERENCES:
http://www.darpa.mil/ipto/programs/cast/index.htm.

KEYWORDS: Language Translation, Image Processing, Text Processing.

ST061-004 TITLE: Robust Self-Forming Human Networks: Making Organizations Work

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Create tools to help organizations automatically restructure themselves to match the current work to be done, and to connect together individuals with common interests and functions but whom the organization chart shows as unconnected.

DESCRIPTION: In moving to an information-economy or a net-centric military, we continue to maintain archaic and static organizational structures that barely worked in the industrial economy, i.e., in manufacturing and large scale military operations. In the past there were few alternatives to this kind of hierarchical structure, which can only function by restricting communication across divisional lines. This restriction can lead to massive, wasteful, and often disastrous sub-optimization. Well-managed organizations can sometimes minimize and carefully channel the interactions across those lines but as new tasks develop and unexpected changes occur, even the best Mythical Man-Month kind of organization decays toward rigid and inefficient structures.

New methods are needed to create flexible organizations and inter/intra-organizational collaboration, but the problem of adapting an organization to meet continuously changing circumstances has been stubbornly resistant to social science approaches. In the past it has not been possible for anyone to know a real corporate wiring diagram, let alone create one to match the work being performed. Much of the time people find out what others in an organization are doing only by accident. Often those accidental encounters are highly productive. This STTR topic asks the performer to develop tools to help make those encounters happen by design, not chance.

Another symptom of this problem comes from the practice of creating a new Joint Task Force Headquarters (JTFHQ) Staffs for each come-as-you-are conflict. Each new JTFHQ Staff member spends a great deal of time in the beginning learning about the others and how they do business. They typically are only half way up the learning curve when the major action occurs. Moreover, modern military network-centric operations rely heavily upon rapid formation (and re-formation) of new multi-functional, adaptive teams and organizations. The tools developed under this topic could help here, too.

The digital component, the background information within a modern organization's personal computers (PCs) and networks, may allow us to derive and expose the existing structure and then modify it to something more optimum. In addition, the same tools should allow us to connect organizationally–distant people who are performing related tasks or communicating with the same people or about the same topics. With such tools we might be able to revolutionize the productivity of flat, high-turnover organizations performing intellectual functions like a military staff or even DARPA.

PHASE I: Describe processes and tools that might lead to characterizing how work is actually performed in a modern organization. Describe similar processes and tools that will connect similarly functioning, but organizationally-distant individuals together. Prototype a limited set of these tools. Describe the character of a test bed to explore the utility of these tools in a Phase II program. Identify an appropriate organization to site the test bed. Issues that must be considered include: privacy, measures of effectiveness, efficiency and scalability, connections to legacy systems and applications, convenience, user acceptance (as well as manager acceptance).

PHASE II: Develop software and prototype it inside an appropriate organization. Iterate. Identify a specific military organization, command post structure, military team, or staff that would benefit from the tools and apply them there in the later stages of the Phase II. Human use protocols and protections will be required for this phase of the work.

PHASE III DUAL USE APPLICATIONS: If successful, these tools could revolutionize the way commercial as well as military organizations work.

REFERENCES:
1. Brooks, F.P., The Mythical Man-Month: Essays on Software Engineering, 20th Anniversary Edition, Addison-Wesley, (Boston, MA), 1995.
2. March, J.G., Sproull, L.S., Tamuz, M., "Learning from Samples of One or Fewer," Organization Science, Vol. 2 No. 1 Feb 1991.
3. Dunbar, R. I. M. (1993). "Coevolution of neocortex size, group size and language in humans." Behavioral and Brain Sciences 16 (4):681-735.
4. Scott, W. R. (2002). Organizations: Rational, Natural, and Open Systems, 5th Edition. Englewood Cliffs, NJ, Prentice Hall.
5. Gladwell, Malcom. (2002). The Tipping Point: How Little Things Can Make a Big Difference. Little Brown & Co.
6. Chatham, R., Braddock, J. Training for Future Conflicts, report of a task force of the Defense Science Board (www.acq.osd.mil/dsb/reports.htm) 2003

KEYWORDS: Organizational Structures, Human Networks, JOINT Task Force Headquarters Staff.

ST061-005 TITLE: <u>Adaptive Skin-Stiffener Interconnects for Shape-Changing Vehicles</u>

TECHNOLOGY AREAS: Air Platform, Materials/Processes, Electronics

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop an interconnect system between a structural member and a flexible skin for a shape-changing vehicle that can withstand repeated strains of greater than 100% in the skin and change its material properties in real time to reduce power required for shape change.

DESCRIPTION: New generations of autonomous combat vehicles will incorporate multi-mission capability through the use of ‘morphing’ structures that exhibit large shape change. Morphing aircraft structures require load-bearing structural members and flexible skins that maintain the shape required for aerodynamic efficiency. The interconnection between the stiff structural component and the flexible skin presents a technical challenge because of the substantial mechanical impedance mismatch between the two components. This mismatch in mechanical impedance produces large stress gradients that lead to failure at the interface and can cause rippling under aerodynamic loads, in large part due to the large strains imposed by the shape change of the vehicle. In addition to introducing the possibility of failure, the strain energy stored at the skin-stiffener interface substantially increases the amount of power required for the shape change. New interconnect systems that automatically adapt their material properties to minimize the power required for shape change are of substantial interest.

PHASE I: Assess the feasibility of an interconnect system that consists of a stiffener and attached flexible skin. The flexible skin must be able to withstand strains in excess of 100% in the skin for greater than 100 cycles. Perform analyses to determine stress gradients at the interface when undergoing strain in excess of 100% in the skin. Develop concepts for a variable modulus skin that will reduce strain energy stored during shape change by at least a factor of 10.

PHASE II: Fabricate a prototype skin-stiffener interconnect and perform tests to assess its cyclic fatigue properties. Demonstrate real-time control of material properties and quantify the reduction in power requirements when undergoing large strains. Incorporate into concept aerodynamic surface and quantify impact on shape-changing capability. Develop methods for processing the material so that it can be manufactured in a desired shape to enable slight contours on the aerodynamic surfaces.

PHASE III DUAL USE APPLICATIONS: Large deployable structures would benefit from the development of robust and adaptive interconnection systems. Materials that exhibit large, controllable changes in mechanical properties would have use in biomedical applications such as ‘smart’ sutures.

REFERENCES:
1. Shape-memory polymer changes from rigid to elastic. Advanced Materials & Processes, Apr2005, Vol. 163 Issue 4, p14.
2. Shape-memory polymers see the light: Polymers. by: Borchardt, John K.. Materials Today, Jun2005, Vol. 8 Issue 6, p15.
3. Aerodynamic and Static Aeroelastic Characteristics of a Variable-Span Morphing Wing. by: Jae-Sung Bae; Seigler, T. Michael; Inman, Daniel J.. Journal of Aircraft, Mar/Apr2005, Vol. 42 Issue 2, p528.

KEYWORDS: Shape-Changing Vehicles, Adaptive Materials, Flexible Skins.

ST061-006 TITLE: Fully Addressable Variable Resolution Display Technology

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Design, construct and test a combined software/hardware system that enables color displays that have pixels of arbitrary spatial shape and support an arbitrary number of bits on each of the color planes.

DESCRIPTION: Display technology has reflected the belief that displays should consist of square arrays consisting of N x N pixels with 3M bits on each of the color planes. Recent advances in display technology have focused on increasing the spatial resolution N or increasing the number of bits associated with the color M. At the same time modern signal and image processing algorithms have moved from pixel based schemes to non-pixel based schemes such as those that occur with partial differential equation based methods or embedded bit streams that are allowed under standards such as JPEG2000. Consider the situation with respect to JPEG2000. Considerable computational effort goes into developing an embedded bit stream which is then transmitted and received. In order to display the image, restored image must be post processed and converted from the wavelet representation to a pixel representation and bits added to each pixel in order to accommodate the display technology. These remaining steps require computation and Central Processing Unit (CPU) time which can be significant for large images which can negate the benefit of the original compression. It is precisely these last steps that we wish to avoid, i.e. we seek a combined software/hardware system that is capable of displaying JPEG2000 like embedded bitstreams including those with region of interest encoding, MPEG-4, and non-pixel based image formats and that support a variable number of bits within the region that is backwards compatible with current display technologies and video cards.

PHASE I: Prepare a feasibility study to identify and define a concept that would enable a display to provide addressable, variable size, non pixel based regions with an arbitrary number of color bits. Perform modeling and simulation of the identified concept and define metrics that will be required to support Phase II and Phase III activity.

PHASE II: Construct and demonstrate the operation of a prototype display system based upon the concept identified in Phase I. Demonstrate the prototype in accordance with the metrics developed in Phase I.

PHASE III DUAL USE APPLICATIONS: This system could be used in a broad range of military and civilian security applications where images and video sequences are displayed including High Definition Television, computer games, visualization, and targeting.

REFERENCES:
1. David Taubman, JPEG2000: Image Compression Fundamentals, Standards, and Practice, Kluwer Academic Publishers, 2002.
2. G. Sapiro, Geometric Partial Differential Equations and Image Processing, Cambridge University Press, January 2001.
3. E. J. Candès and T. Tao (2004). Near Optimal Signal Recovery from Random Projections: Universal Encoding Strategies, Submitted for publication. PDF available at http://www.acm.caltech.edu/~emmanuel/papers/OptimalRecovery.pdf.

KEYWORDS: Display, Monitor, Variable Addressing, Non-Pixel Based Processing, Variable Color Plane.

ST061-007 TITLE: Fiber Reinforced Shape Changing Polymer Composites

TECHNOLOGY AREAS: Air Platform, Ground/Sea Vehicles, Materials/Processes

OBJECTIVE: Develop novel fiber (or fabric) reinforced polymer matrix composites and associated composite configuration concepts suitable for applications in shape changing structures, including aircraft and ground vehicles. These concepts must be compatible with active morphing or reconfigurable structural concepts to provide sufficient strength and stiffness with the additional ability to be easily actuated, by external actuation, into highly distorted shapes for high performance aerospace and other terrestrial applications.

DESCRIPTION: Reconfigurable systems, including morphing aircraft, have the ability to change fundamental system performance characteristics (aerodynamic spectrum, visible spectrum, and/or functional spectrum) to adapt to mission needs while still maintaining optimal performance. An example is an unmanned aerial vehicle (UAV) that can change configurations from high-speed dash to efficient loiter. Changing between these two configurations requires large shape changes, such as changed surface area or panel curvatures while at the same time being able to carry substantial out-of-plane loads and to be "situational functional" that is, able to be switched rapidly from one state to another and then back again. Because of the mechanical and lightweight requirements, fiber reinforced composites are the preferred materials for many of these structures. Current devices use silicone materials reinforced with titanium or other high strength wire, but these materials have limitations. Various shape memory polymers or electro-active polymer systems in their un-reinforced states have demonstrated the capability of performing shape changing functions but have insufficient mechanical properties to be used in highly loaded applications. Photonically or thermally activated shape memory polymer matrix fabric reinforced composite have recently been suggested and some devices demonstrated at the rudimentary level. This solicitation seeks advanced, innovative material concepts to improve performance of current highly loaded flexible panels as well as monolithic, thermally activated, shape memory composites. The improvement metrics include faster response mechanisms to activate the shape change, higher operational temperature and/or improved mechanical properties, particularly strength and stiffness. Major challenges include identifying faster response shape changing activation mechanisms, such as photonic activation, in a polymer matrix that is also compatible with fiber reinforced composite processing and fabrication, higher glass transition temperature matrix, and reinforcement architecture compatible with the desired shape change and required mechanical properties.

PHASE I: Develop and evaluate proposed composite material concepts to yield proof of principle data to substantiate the potential of reaching program end goals. Demonstrate shape changing function in a fiber reinforced composite laminate. Characterize the laminate mechanical properties and the shape changing response time.

PHASE II: Based on Phase I results, further develop the proposed material system, focusing on integrating the activation control with the laminate structure. Finally, fabricate a representative structural component with the mechanically adaptive composite structure to demonstrate its shape changing functionality and to characterize its mechanical performance characteristics.

PHASE III DUAL USE APPLICATIONS: Mechanically adaptive structures for automobiles and ships, prosthetic devices.

REFERENCES:
1. Strange Shapes,Graham Warwick, Flight International, September 13, 2005.
2. "High Strain Fiber Reinforced Reusable Shape Memory Polymer Mandrels," Matthew Everhart and Jaime Stahl, 2005 SAMPE, Long Beach, CA

KEYWORDS: Polymer Fiber Reinforced Composites, Shape Changing Materials, Morphing Air Vehicles.

ST061-008 TITLE: <u>Modification of Wireless Fidelity Communication Devices to Support the Urban Warrior</u>

TECHNOLOGY AREAS: Information Systems, Sensors, Electronics, Battlespace, Human Systems

OBJECTIVE: Determine the feasibility of modifying commercial Wireless Fidelity (WIFI) technology with state-of-the-art Silicon Germanium (SiGe) Bipolar Complementary Metal Oxide Semiconductor (BiCMOS) mixed signal Application-Specific Integrated Circuit (ASICs) to enable robust, ultra-compact, ultra-low power, portable communication devices to support squad leader and foot soldiers in the urban warfare environment.

DESCRIPTION: Advances in commercial WIFI communication technology together with standardization of interfaces to portable computing resources have fueled the widespread adoption of diverse wireless networked data processing platforms ranging from laptop computers to personal digital assistant (PDA) type entertainment devices such as the Sony Playstation. Stiff market competition has driven significant advances in system integration, resulting in plug-and-play consumer products which are compact, power efficient with long battery life, and capable of remarkably advanced networked data processing.

There is an exciting opportunity for innovative enhancement and augmentation of this underlying commercial technology with state-of-the-art SiGe BiCMOS mixed signal technology and advanced digital signal processing algorithms in order to provide extremely compact, agile, and low-power radio frequency (RF) “eyes, ears, and voice” for dismounts operating in the urban environment. It is envisioned that RF voice, imagery, and data communication; navigation; and sensor support capabilities may some day be provided in the format of a very small, low-power auxiliary device, called a dongle, attached to a portable computing platform via its Universal Serial Bus (USB) interface.

Successful development of this technology would have profound positive impact on small unit operations. For example, future urban warfare tactics will require highly coordinated maneuver and fire support as small teams enter a building or city area. Team performance would be greatly enhanced by efficient wireless communication of voice, data, and imagery, both within the team as well as with micro-Unmanned Aerial Vehicle (UAV) surveillance and other external resources.

To this end, the potential for a ruggedized, low-power, communication dongle based on WIFI standards will be investigated. The ultimate goal will be a highly flexible, interoperable device designed to operate at 1 Mb/s data rates at a range of 1 km outside and 100 m inside a building. The device will be powered and data-interfaced via USB to a PDA type device. The single battery lifetime of the combined PDA-dongle system will be compatible with mission duration requirements.

PHASE I: Develop and determine feasibility of an overall design including specification of RF link, physical layer, antenna, and USB interface. The proposed design approach must overcome the technical challenge of ruggedization, portability, and sustained low-power operation.

PHASE II: Develop and demonstrate a prototype system. Conduct testing to prove feasibility in realistic operating environment.

PHASE III DUAL USE APPLICATIONS: This technology will be useful in a wide range of military and civilian applications requiring reliable wireless networking of mobile light-weight data processing devices operating in a harsh environment. In particular, it will support coordination and situational awareness for small teams of dismounts operating in urban environments. Civilian applications include maritime, industrial manufacturing, emergency first responders, and construction.

REFERENCES:

1. http://www.us.playstation.com/.
2. http://grouper.ieee.org/groups/802/11/.

KEYWORDS: Radio-Frequency Components, Microelectronics, Electronics Integration Technology, Wireless Communication, Urban Warfare, Strategic Corporal, WIFI.

ST061-009 TITLE: Extending the Performance of High Power Laser Diode Arrays

TECHNOLOGY AREAS: Chemical/Bio Defense, Materials/Processes, Sensors, Electronics, Battlespace, Human Systems, Weapons

OBJECTIVE: Develop intelligent laser diode array (LDA) drivers and laser diode array diagnostics to extend the performance, lifetime, and reliability of high power LDAs.

DESCRIPTION: The performance and lifetime of individual laser diodes, diode bars and arrays of diode bars are limited by filamentation (at the individual diode emitter) and current hogging (from emitter-to-emitter within a diode bar) instabilities. These instabilities lead to increased laser diode emitter temperature and ultimately to emitter failure. Unfortunately, when diode emitters fail within the structure of an LDA, the root cause of that failure is typically lost in the catastrophic nature of the failure such that a post-mortem analysis reveals little. Furthermore, once the catastrophic event has occurred, the opportunity to prevent or mitigate that failure is lost.

This solicitation seeks technology which senses the onset of filamentation and current hogging instabilities and then takes corrective action before permanent damage to individual emitters can occur, thereby extending the lifetime of the array.

PHASE I: Conduct a feasibility study to demonstrate that the onset of filamentation and current hogging instabilities within individual laser diodes and diode bars can be sensed in real time. Use this information to perform a preliminary design of experiments that will demonstrate that diode laser driver circuitry can be developed to interrupt the growth of these instabilities before permanent emitter damage occurs. Prepare a final technical report that details results from the Phase I effort.

PHASE II: Utilize the diode array driver concepts developed in Phase I to extend LDA lifetime by more than a factor-of-10 as demonstrated in accelerated lifetests and in fully-instrumented, long-duration experiments designed to measure diode array lifetime. Prepare a final technical report that details experimental results from the Phase II effort.

PHASE III DUAL USE APPLICATIONS: The technology will be automated and integrated into intelligent diode laser bar and array drivers used in powering both commercial and military high power diode arrays. Military applications include laser target designation, laser range-finding, laser communications, chemical and biological sensing, identification, friend or foe (IFF), and high power laser weapons for battlefield applications. Civilian applications include laser metal working, welding, laser communications, and high brightness laser displays with special applications in large theaters and in direct sunlight.

REFERENCES:
Carter, J. and Snyder, D. “Spatially and Temporally Resolved Temperature Measurement of Laser Diode Arrays.” Proceedings of the 2005 American Society of Mechanical Engineers Heat Transfer Conference. July 17-22, 2005.

KEYWORDS: Laser Diode Arrays, Thermal Characterization, Reliability, Intelligent Power Supplies, Materials and Processes.

ST061-010 TITLE: Non-Toxic Chemical Formulation for Incapacitation and Destruction of Small Arms and Light Weapons

TECHNOLOGY AREAS: Materials/Processes, Weapons

The technology within this topic is restricted under the International Traffic in Arms Regulation (ITAR), which controls the export and import of defense-related material and services. Offerors must disclose any proposed use of foreign nationals, their country of origin, and what tasks each would accomplish in the statement of work in accordance with section 3.5.b.(7) of the solicitation.

OBJECTIVE: Develop a non-toxic chemical formulation that instantly renders stockpiles or caches of military small arms (e.g., rifles) non-operational upon contact, and which further provides for longer time-scale destruction of the weapon firing mechanism by corrosion or other processes.

DESCRIPTION: Small arms and light weapons pose a significant threat to both US warfighters and local civilians in the Urban Battlespace, as exemplified by Iraqi cities such as Baghdad and Fallujah. The 2004 Small Arms Survey estimates that at least 7 million small arms, including AK-47 rifles, rocket launchers and mortar tubes, and more sophisticated arms like ground-to-air missiles, have fallen into the hands of Iraqi civilians since the fall of Saddam Hussein in 2003.[1]

Resolving the issue of small arms involves three steps: systematically searching for weapons caches, securing them, and destroying them. US forces routinely discover significant weapons caches during raids and other operations. However, the extremely large number of both weapons and storage sites has rendered global securing and destruction of caches nearly impossible. Significant reduction in small arms stockpiles requires that weapons caches be rapidly neutralized “in-situ” at the point of discovery.
This topic seeks the development of a novel non-toxic chemical formulation for incapacitation and destruction of caches of small arms. This formulation, when applied to caches of weapons by simple means (e.g., spraying), will penetrate rapidly into the active firing and/or actuation mechanisms[2] and render them instantly and permanently inoperable. Furthermore, the formulation will produce an accelerated corrosion (or other) reaction over a longer period of time (a few months or less), perhaps using the weapon material itself as a metallic catalyst, to destroy the weapon internal structure. The formulation must be effective in small quantities (i.e., a few grams per weapon), safe to use, stable over the range of operational temperature/humidity conditions, have a long shelf-life, be capable of large-area dissemination, and produce a non-toxic residue after the weapon is destroyed. Furthermore, it must not

be reversed by simple chemical, thermal, or other means. Such a chemical system has the potential to enable the systematic and effective removal of small arms from the battlespace.

PHASE I: Conduct initial research and develop a preliminary functional design of a prototype chemical formulation for incapacitation and destruction of caches of small arms exhibiting the desired features described above. Demonstrate feasibility of rapid (< 5 min) permanent incapacitation of both an automatic rifle firing mechanism and a launcher motor using the formulation.

PHASE II: Refine the Phase I formulation to include the capability of corrosive (or other) weapon destruction. Develop a prototype dispensing system and demonstrate incapacitation and destruction of a small cache of automatic rifles and a rocket or mortar launcher.

PHASE III DUAL USE APPLICATIONS: Chemical incapacitation technology should provide significant benefits in the area of law enforcement.

REFERENCES:
1. Graduate Institute of International Studies, “Small Arms Survey 2004: Rights at Risk,” Oxford University Press (New York, 2004).
2. Richard Jones, Jane’s Infantry Weapons 2005-06, (Jane’s Information Group, 2005).

KEYWORDS: Chemical, Penetrant, Small Arms, Incapacitation, Destruction, Rapid, Corrosion.

ST061-011 TITLE: Responsive Secondary Payload Launch

TECHNOLOGY AREAS: Air Platform, Space Platforms

OBJECTIVE: Identify and develop innovative system concepts for non-intrusive parasitic power transfer and non-intrusive communications between large (host) and small (drone) satellites operating in close proximity.

DESCRIPTION: Small satellites because of their size are limited in the amount of onboard power they can store. When operating independently, small satellite size constraints can impose significant limitations on mission capabilities due to reduced resources for propulsion, internal power and communications. Certain mission scenarios may provide opportunities for parasitic power extraction from larger host satellites, thereby extending the utility and lifespan of smaller “drone” satellite operating in close proximity to the larger “host” satellite. These small satellites could use existing power sources such as RF transmissions to extract the small amount of power necessary for their activities. This parasitic power beaming could utilize non-intrusive means to make use of power generated in the host satellite’s RF communication system sidelobes. Technologies exist for beaming and conversion of microwave energy to electrical energy as summarized in reference 1 below. Such technologies need to be investigated for their potential application to small drone satellites. These drone satellites could also communicate with the mother ship through existing communication links in a manner similar to ground-based wireless networks. A potential scenario for deployment of these drone satellites is to carry them as secondary payloads with the host satellite during the initial launch, similar to the SNAP-1 mission described in reference 2 below. As part of this topic concepts are solicited to develop and design candidate interfaces for launching parasitic secondary space payloads (<20 kg) from emerging responsive launch vehicles, such as those under development by the DARPA/USAF FALCON Program. Potential missions for these drone satellites could include inspection of host satellite resources (solar arrays, antenna surfaces and alignment, etc.) and inspection of the immediate volumes of space near the host satellite to detect debris and the presence of otherwise undetected objects. For existing satellites already on orbit, a cluster of drone satellites could be delivered to the proximity of the host satellite.

PHASE I: Conduct an assessment of parasitic RF power beaming concepts and capabilities with direct applicability to smallsat drone applications. Identify candidate power beaming approaches and prepare preliminary system performance predictions and secondary launch interface concepts for drone smallsats.

PHASE II: Develop preliminary designs for parasitic drone smallsats from the information derived in Phase I. Identify enabling technologies, develop and conduct ground-based demonstrations to establish concept viability. Utilize ground based test efforts to define space-based demonstration plans.

PHASE III DUAL USE APPLICATIONS: The technology developed under this SBIR can be used in military and civilian commercial satellite systems that could benefit from additional external inspection sensors to monitor system health and status.

REFERENCES:
1. An Attitude Control System and Commissioning Results of the SNAP-1 Nanosatellite, WH Steyn, Y Hashida and V Lappas, Surrey Space Centre, UK, 14th AIAA/USU Conference on Small Satellites, August, 2000, SSC00-VIII-8
2. Space Propulsion and Power Beaming Using Millimeter Systems, J. Benford, Physics International Company, CA, R. Dickinson, Jet Propulsion Laboratory, CA, SEP 1995, SPIE Vol. 2557
3. New Technologies in Space, is the US Losing Ground, 17th Annual AIAA/USU Conference on Small Satellites, SSC03-III-I

KEYWORDS: Responsive, Launcher, Secondary Payloads, Space Integration, Launch Vehicle, On-Orbit Testing, FALCON.